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ONTARIO BUDGET PAPER

R & D and Economic Development in Ontario: A Discussion Paper

The Honourable Frank S. Miller
Treasurer of Ontario

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Presented for the Information of the Members
of the Legislative Assembly of Ontario
by the Honourable Frank S. Miller,
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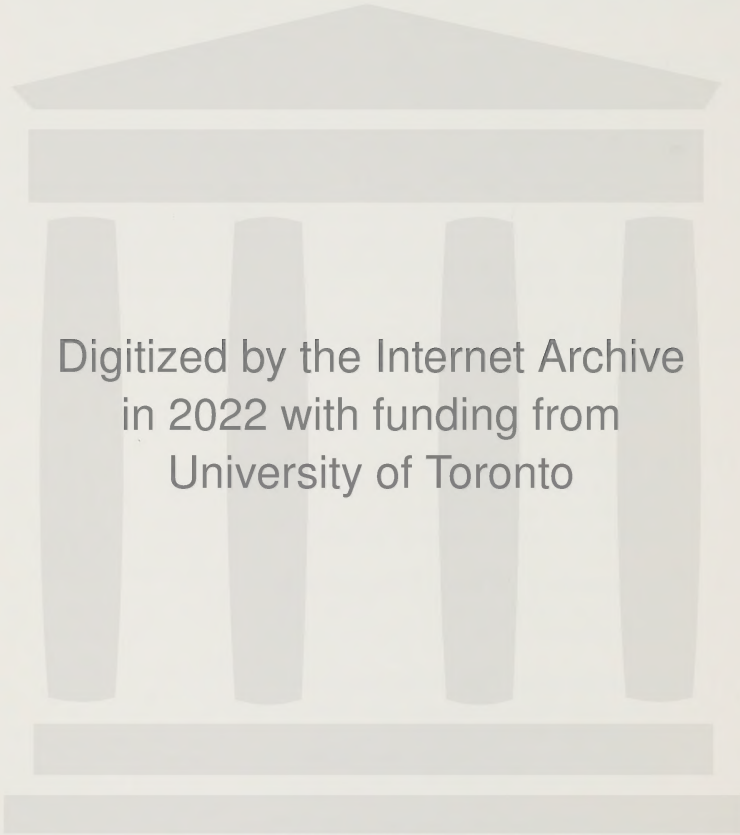

R&D and Economic Development in Ontario: A Discussion Paper

Introduction

In recent years, Canada's relatively low performance in research and development compared to other countries has been the subject of considerable public discussion.[1] Both the causes and consequences of this underperformance have motivated the introduction of a number of policies supportive of R&D. Underlying these actions is the recognition that commercial innovation has become critical to economic performance in a world increasingly driven by rapid rates of technological change.

The first section of this paper addresses the importance of R&D to economic development. Section II reviews the R&D record in Canada and Ontario. Section III examines certain key structural factors which influence the level of R&D performance. Fundamental policy issues relevant to R&D are considered in Section IV. Sections V and VI review the various tax and funding programs which assist R&D performance in Ontario. Section VII briefly reviews several broader economic policies which have significant effects on R&D performance and is followed by a concluding section.

I The Importance of R&D

A restructuring of the world economy is occurring as it becomes increasingly integrated through international trade and investment. The developing market economies increased their share of world exports from 18 per cent in 1970 to 28 per cent in 1981. The shifts in economic activity which these trade statistics reflect are forcing difficult adjustments on the developed countries, including Canada.

Like Japan during the early stages of its post-war growth, the developing countries are achieving their greatest manufacturing successes in the standard-technology, low-skill, labour-intensive industries. When modern manufacturing technology can be purchased from advanced countries and operated by relatively unskilled personnel at low rates of remuneration, the cost advantage over countries such as Canada can be insurmountable.

For the advanced industrialized countries as a group, it is widely expected that economic resources increasingly will be shifted into industries which reflect their comparative advantage, relative to the developing economies, in knowledge-intensive activities. The vastly greater per capita wealth and annual income of Canada and other industrialized countries allows them to invest in the infrastructure and human capital formation which knowledge-intensive industries require.

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[1]The expression R&D performance is used in this paper to denote the actual expenditures by a person, firm or institution on R&D activity. It is useful to make a distinction between the performers of R&D and the sources of R&D funding. R&D activity is often performed by other than those who fund it. For example, governments may fund R&D activity in industry, and businesses may contract R&D work to universities.

Performance of R&D relative to the size of a country's economy is often considered an index of its comparative advantage in knowledge-intensive activities. A major disadvantage of using R&D as an index is that other knowledge- and skill-based functions such as design, engineering, marketing and start-up or customized production are ignored. Also overlooked is the transfer of the results of R&D across international boundaries, in particular through foreign subsidiaries. While R&D performance is a useful proxy of knowledge intensity, it has important limitations.

A shift in the comparative advantage of the advanced industrialized countries towards knowledge-intensive industries will occur for the most part through the interplay of market forces. Restructuring the economy primarily requires that actions be taken by individuals and private firms; however, government policies should facilitate restructuring. Furthermore, the prospect of Canada's comparative advantage shifting towards knowledge-intensive industries in the future increases the importance of ensuring that governments support the efficient development of these industries. With respect to R&D, this includes the need for appropriate policies for funding of R&D and the need for consistency in a wide range of other policies potentially affecting R&D performance.

II The R&D Record

International Comparisons

Canada's R&D effort can be placed in perspective through comparisons with other advanced countries in the Organization for Economic Co-operation and Development (OECD). Relative to the size of its economy, Canadian expenditures on R&D during the last two decades have consistently lagged behind those of major industrial competitors, as shown in Table 1. While OECD comparisons are useful as a benchmark for gauging national performance, it must be recognized that variations in industry mix, as well as other factors, will influence economy-wide measures of R&D intensity. In this regard, Canada's relatively low R&D performance, in part, reflects its industrial make-up and its comparative advantage in natural resources. As well, Canada spends less on defence-related R&D than do most other OECD countries.

Canada's R&D Effort Relative to Selected OECD Countries: Selected Years — Table 1
(per cent)

	Ratio of R&D (NSE+SSH)[1] to GDP			Ratio of R&D (NSE)[1] to GDP
	1963	1971	1979	1979
Canada	1.0	1.2	1.1	1.0
France	1.6	1.9	1.8	n.a.
Germany	1.4[2]	2.1	2.4	2.3
Japan	1.3	1.6	2.0	1.8
Sweden	1.3[2]	1.5	n.a.	1.9
United Kingdom	2.3[2]	2.1[3]	2.2	2.1
United States	2.9	2.6	2.4	n.a.

Sources: OECD, *Technical Change and Economic Policy*, 1980 and *International Statistical Year 1979: Main Results*, March 1982.

[1]OECD statistics on R&D distinguish between that based on Natural Sciences and Engineering (NSE) and that based on Social Sciences and Humanities (SSH).
[2]1964.
[3]1972.
n.a. — not available.

In response to concern over Canada's relative underperformance of R&D, governments have introduced a wide array of R&D enhancing policies. In 1981, the federal government announced a policy target of raising the level of natural sciences and engineering-based R&D to 1.5 per cent of GNP by 1985. Although the 1.5 per cent level is a somewhat arbitrary target, there is a growing consensus in government and business that the federal objective provides a useful indicator for evaluating changes in R&D performance.

Canada's Effort

Preliminary estimates shown in Table 2 indicate that R&D spending by Canadian businesses, governments, universities and private non-profit research organizations will be $5.2 billion in 1983. As a percentage of GNP, R&D is estimated to rise to a record 1.39 per cent in 1983, continuing the upward trend which began in 1976.

Canada's R&D Spending:[1] Selected Years — Table 2
($ million)

	R&D Spending	Per Cent of GNP
1963	463	1.01
1967	854	1.29
1972	1,189	1.13
1976	1,828	0.96
1980	3,187	1.09
1981	3,864	1.17
1982[2]	4,697	1.34
1983[2]	5,224	1.39

Source: Statistics Canada, *Science Statistics Service Bulletin*, March 1983.
[1]In keeping with Statistics Canada's conventions, these figures are for Natural Sciences and Engineering-based R&D only, and exclude expenditures on R&D in the Social Sciences and Humanities.
[2]Preliminary figures from Statistics Canada, Science Statistics Centre.

By the end of 1983, it is estimated that total R&D expenditures will have grown in real terms at an average annual rate of 6.7 per cent since 1976. In comparison, real R&D expenditures averaged annual growth of less than two per cent between 1967 and 1976. Moreover, growth rates continue to surge, with real R&D expenditures projected to increase at an average annual rate of 8.1 per cent during the three years ending in 1983. This recent acceleration is all the more striking in light of the weak overall performance of the economy during this period.

The recovery in R&D expenditures reflects increased tax preferences for R&D and the relatively more rapid growth of Canadian-owned firms in technology-intensive industries. In addition, about half of the recent increase in the R&D to GNP ratio is attributable to the rapid expansion of R&D by the oil and gas, petroleum products and electrical power industries. Since 1973, the energy sector has more than tripled its share of total domestic R&D expenditure, increasing from 4.6 per cent to the current level of 17.1 per cent. Moreover, the rapid change in the relative price of oil over the last decade has led to increased R&D spending in the development of less energy-intensive capital and consumer goods in the manufacturing sector.

Performance

Economic benefits from R&D are greatest when research is undertaken by industry because firms' exposure to the marketplace enhances the prospects for commercializing innovations. This explains the policy emphasis of governments in Canada on raising business-performed R&D, which is often referred to as "industrial R&D".

Although the business sector continues to perform a smaller share of R&D in Canada than in most other major OECD nations, this discrepancy is being narrowed. Recent statistics for the major OECD countries indicate that business enterprises perform 60 to 70 per cent of natural science and engineering R&D. Statistics Canada estimates business enterprises will perform 56 per cent, or $2.9 billion, of R&D in Canada in 1983. As indicated in Table 3, this marks a substantial increase in the share of R&D performed by business. These gains have been due to a real strengthening of business R&D relative to the size of the economy rather than simply weakness in other R&D performing sectors.

Canada's R&D Performance, by Sector: Selected Years — Table 3
(per cent)

	Federal Government	Provincial Government[1]	Business Enterprise	Higher Education[1]	Total[2]
1963	37.8	3.7	38.9	19.4	100.0
1976	27.8	3.8	41.3	27.0	100.0
1981	22.4	3.5	51.9	22.2	100.0
1982[3]	21.6	3.5	54.8	20.1	100.0
1983[3]	21.0	3.5	55.6	19.9	100.0

Source: Statistics Canada, Science Statistics Centre.
[1]Provincial government includes provincial research organizations; higher education includes private non-profit research centres.
[2]Figures may not add due to rounding.
[3]Preliminary figures.

Funding

The less active role of industry in the performance of R&D in Canada relative to other major OECD countries is paralleled by a smaller business sector contribution to R&D funding. OECD statistics for 1979 show that business enterprises financed 40 to 60 per cent of R&D in major OECD countries.

Canada's R&D Funding, by Sector: Selected Years — Table 4
(per cent)

	Federal Government	Provincial Government[1]	Business Enterprise	Higher Education	Other[1]	Total[2]
1963	48.6	4.1	31.3	12.5	3.5	100.0
1976	41.0	6.7	33.7	14.3	4.3	100.0
1981	35.4	6.8	43.1	9.0	5.7	100.0
1982[3]	34.1	6.6	45.5	8.0	5.8	100.0
1983[3]	33.4	6.6	46.2	8.0	5.8	100.0

Source: Statistics Canada, Science Statistics Centre.
[1]Provincial government includes provincial research organizations; other includes private non-profit funding and foreign funding.
[2]Total may not add due to rounding.
[3]Preliminary figures.

In 1983, 46 per cent of Canadian R&D will be funded by business enterprises, significantly up from 34 per cent in 1976. At the same time, as Table 4 shows, the federal government share of R&D funding is declining. However, this does not take into account the trends in, nor the significance of, federal tax expenditures on R&D which, along with provincial tax support, have been the primary vehicle for public assistance of R&D in Canada.

Sectoral Composition of Industrial R&D

In Canada, as in other countries, the bulk of industrial R&D has been carried out by the manufacturing sector — 78 per cent in 1977, as shown in Table 5. In most other countries manufacturing performs an even larger share of industrial R&D. The relative importance in Canada of R&D by the mining and service sectors (including communications and electrical utilities) reflects their prominence in the economy. Not only is Canada's industrial R&D relatively resource-oriented, it is becoming more so. As a consequence of growth in the energy sector, and in energy-related R&D, Statistics Canada estimates that the manufacturing share of industrial R&D will decrease from 84 per cent in 1973 to 73 per cent in 1983.

Industrial R&D in Selected OECD Countries, by Industry: 1977 Table 5
(per cent)

	Canada	U.S.	Sweden	France	Germany	Japan	Australia
Agriculture	n.a.	*	1.8	0.6	**	0.2	n.a.
Mining	6.7	*	0.6	0.8	2.3	0.4	2.1
Manufacturing	77.8	96.8	89.9	93.0	92.2	91.2	63.3
electrical	21.3	19.9	19.8	27.7[1]	26.2	23.8[1]	10.8
chemical	16.9	14.0	11.6	18.3	26.9	19.6	13.8
aircraft	11.2	23.7	***	18.6	7.2	***	***
transport	1.7	11.6	20.3	11.9	12.2	17.0	7.5
metals	8.5	3.1	8.3	3.7	2.8	8.2	11.8
machinery	8.2[1]	18.0[1]	18.9[1]	5.0	14.1[1]	10.8	6.5[1]
chemical-linked	4.6	3.2	4.1	5.6	2.0	5.6	8.6
other	5.4	3.3	6.8	2.2	0.8	6.3	4.4
Services	15.5	3.2	7.8	5.6	3.5	8.2	34.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: OECD, *Science Resources Newsletter*, No. 5, Summer 1980.
Note: Statistics are for 1977-78 in the cases of Canada, Sweden and Japan, and for 1976-77 in the case of Australia.
[1]Including computers.
* Included in Services.
** Less than 0.005 per cent.
***Aircraft included with transport.
n.a. — not available.

Distribution of R&D by Province

There is a tendency towards the geographic concentration of R&D performance because easy access to a pool of specialized suppliers, informed venture capitalists, and skilled manpower creates self-reinforcing advantages for R&D.

In Canada, R&D performance is concentrated in Ontario. In 1980, just over half of national R&D, or $1.6 billion, was performed in Ontario, as shown in Table 6. This expenditure amounted to 1.4 per cent of Provincial Gross Domestic Product. The concentration of R&D in Ontario can be traced to the size of the province's manufacturing industry and to the presence of a large part of the federal government's R&D establishment in Ottawa. If industrial R&D alone is considered, Ontario accounted for 54 per cent of national expenditures in 1980 or $816 million. Ontario's industrial R&D is diversified with substantial activity in electronics, chemicals and aerospace.

Canada's R&D, by Province: 1977 and 1980 Table 6
(per cent)

	Total		Industrial	
	1977	1980	1977	1980
Total Expenditure ($ million)	2,014	3,097	857	1,500
Distribution by Province				
Ontario	51	51	54	54
Quebec	22	21	27	23
Western Provinces	20	23	15	20
Atlantic Provinces	6	5	1	1
Canada[1]	100	100	100	100

Sources: Statistics Canada, *Science Statistics Service Bulletin*, September 1982 and *Standard Industrial R&D Tables 1963-1982*, June 1982.
[1]Includes R&D performed in the Yukon and Northwest Territories.

III Structural Determinants of Industrial R&D

In international comparisons, domestic market size, market structure and ownership have been identified as significant structural determinants of R&D performance. They all operate to impede R&D in Canada where the economic structure is characterized by limited access to large markets, a relatively small number of large firms, and a high level of foreign ownership.

Market Size

A country's commitment of resources to innovative activity is closely related to the overall size of its market. Regardless of the size of the market, R&D costs associated with a given innovation remain fixed. As sales increase, the R&D costs per unit decline and the return on the R&D investment rises. If the potential market is too small, as is often the case for Canadian firms, innovations will not be attempted. Within the OECD community, Canada's ranking in terms of its R&D to GDP ratio appears closely aligned with its ranking by market size.

Those Canadian firms with successful records of innovation have, in most cases, become heavily involved in export activity. In most cases, success has been based on a degree of technological specialization that would not have been possible in a purely domestic context. For Canada, barriers to international trade, especially in knowledge-intensive industries, adversely affect the climate for R&D.

Firm Size

Large firms account for an overwhelming share of total R&D spending. In 1979, companies with sales in excess of $50 million performed 80 per cent of Canada's industrial R&D.

The concentration of R&D among large firms can be attributed to a number of factors. Large firms face lower risks in innovation through greater diversification and are, therefore, more willing to undertake high risk projects than smaller firms. They are also able to conduct research at lower cost by taking advantage of economies of scale in their R&D performance. Lastly, larger firms may hold important advantages in marketing and distributing new products and so be more adept at commercializing innovations.

However, small corporations also play a dynamic role in many emerging industries, frequently as spin-offs from larger established firms with substantial R&D pro-

Canada's Industrial R&D, by Size of Firm: 1981 Table 7

	Number of Firms	Level of R&D	Share of R&D
		($ million)	(per cent)
Sales less than $1 million	183	39	1.9
Sales of $1 to $9 million	332	110	5.5
Sales of $10 to $49 million	281	205	10.2
Sales exceeding $50 million	306	1,606	80.1
Total[1]	1,122	2,004	100.0

Source: Statistics Canada, *Standard Industrial R&D Tables 1963-1983*, March 1983.
[1]Includes non-commercial industrial R&D.

grams. Moreover, the inventor-entrepreneur has often created the novel concepts that are subsequently perfected and commercialized by large firms. This is commonly facilitated through a takeover by a large firm.

Firms of all sizes contribute to the innovative process. The relative lack of larger-scale firms in Canada, however, represents an important structural impediment toward greater R&D spending in the economy.

Foreign Ownership

Canada's high level of foreign ownership distinguishes it from other OECD nations. Foreign ownership in the manufacturing sector is highest in the research-intensive industries, where access to technology of the parent firm is of the greatest advantage. Drawing on this technology, foreign-controlled firms perform significantly less R&D relative to sales than their Canadian counterparts. For example, in sectors which register the largest R&D expenditures—electrical products, chemicals, aircraft—Canadian-controlled firms have markedly higher R&D to sales ratios than their foreign-owned counterparts. As Table 8 shows, in electrical products Canadian-controlled firms accounted for a 34 per cent market share yet performed 59 per cent of this sector's R&D in 1975. Similarly, Canadian-controlled firms performed high levels of R&D relative to their market shares in chemicals and aircraft.

Canadian and Foreign-Controlled Shares of Sales and R&D in Research-Intensive Industries: 1975 Table 8
(per cent)

	Canadian-Controlled Shares		Foreign-Controlled Shares	
	Sales	R&D	Sales	R&D
Pulp and Paper	56.4	67.2	43.6	32.8
Primary Metals	82.9	86.0	17.1	14.0
ferrous	87.0	88.8	13.0	11.2
non-ferrous	78.6	85.2	21.4	14.8
Electrical	34.4	59.2	65.6	40.8
Machinery	32.5	31.4	67.5	68.6
business machines	14.8	11.3	85.2	88.7
other machinery	35.0	43.8	65.0	56.2
Chemicals	17.1	31.7	82.9	68.3
pharmaceuticals	13.2	29.3	86.8	70.7
other chemicals	18.3	33.2	81.7	66.8
Aircraft Parts	17.3	41.9	82.7	58.1

Source: Ministry of State for Science and Technology, *R&D in Canadian and Foreign-Controlled Manufacturing Firms*, Background Paper No. 9, 1979.

While the impact of foreign ownership varies across industries, the available evidence supports the view that foreign-owned firms allocate fewer resources to R&D than resident-owned firms of comparable size facing similar economic circumstances. The high degree of foreign ownership in Canada's economy in part reflects past tariff policies. However, falling tariff barriers, both at home and abroad, have decreased the incentive to establish branch plants in protected domestic markets. The continued move towards a more liberalized trading environment has created new opportunities for efficient subsidiaries to produce for world markets.

Subsidiaries which obtain product mandates from parent organizations achieve a greater measure of autonomy, assuming responsibility not only for production but also for research, product development and marketing. Over the last decade, a decline in the relative importance of foreign ownership in Canadian industry has been accompanied by an increase in the extent to which foreign subsidiaries compete in global markets. As these changes take root throughout the economy, foreign-owned firms operating in Canada will make a greater contribution to industrial innovation than in the past.

IV The Role of Government

A wide range of government policies influences industrial R&D. Only a few such policies, however, are primarily targeted to have this effect. Governments have attempted to stimulate R&D through policies intended to:

- correct market failures with respect to R&D performance;
- facilitate knowledge-intensive economic development; and
- ensure the availability of highly-qualified manpower.

Each country's circumstances require a distinctive set of policies. Canada's policies should be evaluated within the context of Canadian circumstances rather than by priorities established elsewhere.

R&D Performance and Market Failure

The argument for government assistance to R&D is not simply that there are benefits from R&D but that the market fails to fully recognize these in its allocation of resources. In response to normal market forces, firms will invest in R&D when they expect reasonable returns on their investments. However, it is commonly the case that R&D activity generates benefits not taken into account in private investment decisions.

Private investors may be unwilling to invest in innovation, when the returns can never be fully captured by the innovator, because competitive forces tend to shift the benefits to consumers. This may result in a significant divergence between the private and social rates of return from R&D.

Another basis for public support emerges from the uncertainty surrounding those returns and the extent to which risk discourages the private allocation of resources to innovation. Through shifting risk to the public, government may be able to induce the private sector to allocate more resources to innovative activity so that society as a whole benefits.

Facilitating Economic Development

A second role of government with important consequences for R&D performance is facilitating the development of knowledge-intensive economic activities. This involves supporting the emergence of knowledge-intensive industries and supporting the

introduction of new technologies in more traditional industries by funding R&D itself or, more generally, by strengthening businesses which are then better able to underwrite the cost of their own R&D investments.

Government support of knowledge-intensive industries is an investment intended to pay off in higher living standards. For example, economic development investment in emerging technologies and industries should assist activities which, though not initially commercially viable, can be expected to become internationally competitive and profitable. Government support at the outset allows for the development of supplier industries, consuming industries, final markets, appropriately-trained manpower and experienced management and entrepreneurs. In addition, the private capital markets over time will increase their sophistication and experience in investing in knowledge-intensive industries.

An important aspect of government's role is facilitating adjustments made necessary by changes in comparative advantage and losses in international competitiveness. In some cases, the dislocation of individuals that this implies is considered unacceptable to society and measures are implemented to slow the rate of change, for example, through the temporary restraint of imports. Government action to promote the knowledge-intensive segments of an industry may facilitate socially-acceptable adjustment which will shorten the period of trade protection or, indeed, may serve as an alternative to such policy responses.

Provision of Highly-Qualified Manpower

A third role of government that is significant to R&D performance is the provision of related public sector infrastructure. The most obvious example is public investment in the educational system. An adequate supply of qualified researchers, with graduate level training in the natural or applied sciences is an essential pre-condition for performing R&D. Supplies of manpower with lower levels of qualifications, while not usually a direct constraint on R&D, contribute to the development of domestic industries in which innovations can be commercialized.

An R&D based corporate strategy requires a work force capable of using technically advanced equipment and of adjusting to frequent changes in products and processes. Universities and community colleges play an important role in providing engineers, business graduates, technologists and other trained manpower. They also play a major role in helping firms to adjust to technological change by upgrading and retraining employees.

The highly-qualified manpower required for the performance of R&D is usually drawn from the graduates of university doctoral and masters degree programs. Universities also play an important role by maintaining a base level of expertise in fields that could become important in the future.

In addition to training highly-qualified manpower, universities influence industrial R&D through the conduct of basic research and the performance of contract research. Basic research is unlikely to lead to discoveries that are ready for the market; however, it is the foundation of the R&D effort that leads to the development of commercial products. Recent developments in biotechnology have illustrated the speed with which research topics, once of interest only to academics, can become important to industry.

Universities are becoming increasingly involved in contract research. Small and medium-sized firms, which cannot afford to hire specialists or spend large sums on research equipment, can benefit from the universities' pool of expertise and equipment.

V Tax Treatment of R&D Expenditures

In most industrial countries tax incentives have been an important policy instrument to promote R&D activity. The tax incentives available in Ontario will be discussed next and then put in the context of tax treatment in other industrial jurisdictions.

R&D Tax Policies in Ontario

In order to encourage industry to increase its R&D expenditures in Canada, governments, both at the federal and provincial levels, have put in place relatively generous tax incentives for R&D. Since the mid-1970s, tax expenditures have been enriched as follows:

- in addition to the immediate 100 per cent write off of current R&D expenditures, the March 1977 federal budget extended the investment tax credit to include all current and capital R&D expenditures;
- the April 1978 federal budget allowed an additional 50 per cent write off of the increase in the level of R&D expenditures over the previous three-year average; and
- the November 1978 federal budget increased the investment tax credit for R&D to 25 per cent for all small businesses, 20 per cent for R&D carried out in the Atlantic provinces and the Gaspé peninsula, and 10 per cent in the rest of Canada.

Ontario parallels the first two measures. In the April 1980 Budget, Ontario expanded the scope of the Small Business Development Corporations program in order to encourage R&D in small businesses. A more detailed description of the tax measures affecting R&D available to firms in Ontario provided by the federal and provincial levels of government, including the April 1983 federal budget measures, follows.

Fast Write Off (100 per cent) of R&D Expenditures

Both the Ontario and federal governments allow a 100 per cent write off of current and capital expenditures on R&D incurred in Canada. For R&D expenditures incurred outside of Canada by Canadian firms only current expenditures are deductible. Corporations can carry forward deductions indefinitely. The April 1983 federal budget extended the carry-back provisions to three years.

The 100 per cent deduction of current expenditures generally applies to all other business expenses and therefore does not appear to represent a special incentive for R&D. However, firms tend to view current R&D expenditures as an investment, so the immediate write-off provisions represent relatively generous tax treatment. With the large capital outlays required to start up R&D activities, the 100 per cent write off of capital expenditures helps to underwrite the initial costs of beginning an R&D function in Canada.

The 50 Per Cent Incremental Allowance

The Ontario and federal governments allow corporations to deduct from their taxable income an amount equal to 50 per cent of the increase in current and capital R&D expenditures in a given year over the previous three-year average expenditure incurred in Canada. Current expenditures incurred outside Canada are also included in this calculation. This special deduction is over and above normal write-off provisions for R&D expenditures. It was originally scheduled to remain in place for a ten-year period ending in 1988, however, the April 1983 federal budget proposes to replace this provision with an enriched investment tax credit.

The incremental expenditures claimed against taxable income have increased more than threefold, from $50 million in 1978 to $180 million in 1980. As well, the number of firms claiming the allowance has increased dramatically. As shown in Table 9, the claims were made mostly by large firms, confirming that R&D is for the most part performed by large firms.

Incremental Allowance Claimed and Number of Claimants, by Firm Size:[1] 1978 to 1980 — Table 9

	1978	1979	1980
Allowance Claimed ($ million)			
Small	3	4	6
Medium	4	10	19
Large	43	114	155
Total	50	128	180
Number of Claiming Firms			
Small	20	86	60
Medium	19	56	81
Large	64	120	157
Total	103	262	298

Source: Statistics Canada, *Science Statistics Service Bulletin*, February 1983.
[1]Firm size is defined by value of sales: small—under $10 million; medium—between $10 and $50 million; and large—over $50 million.

Investment Tax Credits for R&D

A five per cent investment tax credit was introduced by the federal government in 1975 for investment in a wide range of new productive facilities for use in a manufacturing or processing business, the production of petroleum or minerals, logging, farming or fishing. In the March 1977 federal budget, the credit was expanded to apply to current and capital expenditures on scientific research and development. At the same time, the rate was increased to 10 per cent for R&D investment in the Atlantic provinces and the Gaspé peninsula and 7.5 per cent in all other parts of the country.

In the November 1978 federal budget, the tax credits for R&D were changed to their current levels. The tax credits, based on R&D expenditures and applied against federal tax liabilities, vary according to the location of R&D performance and the size of firm:

- 25 per cent for Canadian-controlled private small corporations;
- 20 per cent for research carried on by large corporations in the Atlantic provinces and the Gaspé peninsula; and
- 10 per cent for research carried on elsewhere in Canada by large firms and small publicly-held corporations.

Corporations are allowed to apply the credit, which is taxable as income, against all federal income tax liabilities. The April 1983 federal budget announced the extension of the carry-forward provision to seven years and the introduction of a three-year carry back for unused tax credits. It also announced the removal of a $15,000 limit in the application of the credit. As well, the unused tax credits were made refundable under some conditions.

The federal proposal to remove the 50 per cent incremental allowance would involve enriching the R&D tax credit by 10 percentage points. A second proposal would allow companies to transfer the value of their tax incentives to attract outside investors. For a company facing limits on its ability to use the existing R&D tax

incentives, the proposed mechanism would provide the company with immediate cash instead of tax incentives which it cannot use.

As shown in Table 10, the credits claimed and the number of firms claiming the credit grew substantially over the 1978 to 1980 period.

Tax Credits Claimed and Number of Claimants, by Firm Size:[1] 1978 to 1980 — Table 10

	1978	1979	1980
Credits Claimed ($ million)			
Small	1	2	4
Medium	1	3	7
Large	25	49	72
Total	27	54	83
Number of Firms Claiming			
Small	26	86	54
Medium	37	69	63
Large	80	124	149
Total	143	279	266

Source: Statistics Canada, *Science Statistics Service Bulletin*, January 1983.
[1]Firm sizes as defined in Table 9.

Ontario's Small Business Development Program

The Small Business Development Corporations (SBDC) program was introduced in 1979 to encourage equity investment in Ontario-based small business ventures. The SBDC incentive is a grant to individuals or a tax credit to corporations equal to 30 per cent of the cost of equity shares issued by an SBDC. To be an eligible investment for an SBDC, a small business must employ less than 100 persons.

In 1980, the definition of small businesses eligible for investment was extended to include those carrying out "prescribed research and development activities". Such SBDC investments would provide up-front venture capital to allow small entrepreneurs to undertake further research and development on their inventions.

Tax Treatment of R&D by Selected Countries

While all major industrial countries provide for special tax treatment of R&D, these measures vary significantly. For example, all countries allow current expenditures such as wages and salaries and cost of materials for R&D to be completely deducted from income. However, carry-over provisions vary from country to country. The tax treatment of credits and grants is also quite different among countries. Table 11 compares the corporation income tax treatment of R&D expenditures in six major industrialized countries. The Appendix provides a more detailed international comparison of the tax treatment of R&D. Canada's tax treatment of R&D expenditures is the most generous of the OECD community.

When the combined effect of tax expenditures, direct subsidies and the subsidy component of public sector R&D contracts is taken into account, Canada still provides a greater subsidy to R&D activity than any of the 11 other OECD countries surveyed in a recent study.[2]

[2]D. G. McFetridge and J. P. Warda, *Canadian R&D Incentives: Their Adequacy and Impact* (Toronto: Canadian Tax Foundation, February 1983). This confirms the earlier finding of a review of selected industrialized countries that "At the present time Canada has the most generous set of tax incentives and government grants for R&D work". See R. Kaplan, *Tax Policies for R&D and Technological Innovation*, Chapter 1, p. 34 (Washington: National Science Foundation, 1976).

Current Tax Treatment of R&D Expenditures: Selected Countries

Table 11

	Canada	U.S.	U.K.	Germany	France	Japan
Current Expenditures						
Write off (years)	1	1	1	1	1	1
• carry forward (years)	indefinite	15	indefinite	5	5	5
Special Allowance (per cent)	50	—	—	—	—	—
• expenditure base	incremental					
Tax Credit Rate (per cent)	10[1]	25	—	—	—	20[2]
• expenditure base	total	incremental				incremental
• taxable or exempt	taxable	exempt				exempt
• carry forward (years)	7	15				5
Capital Expenditures						
Write off (years)	1	3-15	1	useful life	useful life	useful life
• carry forward (years)	indefinite	15	indefinite	5	5	5
Special Allowance (per cent)	50	—	—	—	—	—
• expenditure base	incremental					
Tax Credit Rate (per cent)	10[1]	6/10[3]	—	7.5[4]	25	—
• expenditure base	total	incremental		total	incremental	
• taxable or exempt	taxable	exempt		exempt	exempt	
• carry forward (years)	7	15		refundable	5	
Corporation Income Tax Rate (per cent)	46	46	52	56	50	42

Source: Ontario Treasury.

[1]25 per cent for small business.
[2]Up to a maximum of 10 per cent of corporate income tax payable.
[3]Applies only to expenditure for equipment and facilities excluding buildings and structures.
[4]20 per cent for the first DM 500,000 (equivalent to $250,000 Canadian).

VI R&D Assistance Policies in Ontario

In addition to the support of industrial R&D provided by its tax expenditures, Ontario directly funds R&D performance and, in later stages, the commercialization and diffusion of innovations. Crown corporations and agencies, including the Urban Transportation Development Corporation and Ontario Hydro, undertake extensive R&D in their own fields. As well, programs of a number of ministries directly and indirectly support industrial R&D. These efforts are co-ordinated by the Board of Industrial Leadership and Development (BILD), which also provides funding.

Board of Industrial Leadership and Development

One of the objectives of BILD is to encourage the development and application of advanced technology in Ontario's traditional industrial base and to nurture the growth of new industries. Of BILD's $1.1 billion in planned expenditures over five years, $503 million or 46 per cent is to be on science and technology projects. These include:

- **IDEA Corporation.** IDEA was established to promote technological innovation and commercial development from private, public and university research. BILD will provide $107 million over five years largely to be used as seed capital to set up five technology funds which will be invested in industries based on developments in microelectronics, the biological and medical sciences, information processing and transmission, chemical and process technologies, and manufacturing automation. The funds will be focussed on start-up situations, where the shortage of equity capital seems most apparent.
- **Technology Centres.** Five major industry-oriented technology centres have been opened, with combined funding commitments from BILD of more than $100 million over five years. These centres will support R&D and the diffusion of new technology.

  Ontario Centre for Automotive Parts Technology. The Centre's objective is to help advance the manufacturing, productivity, technological and managerial strengths of Ontario's auto parts industry. BILD will provide $14.5 million over five years, including funding for technology development.

  Ontario Centre for Resource Machinery. BILD will provide the Centre with $20 million over five years to support the funding of R&D on, and manufacturing of, machinery for the mining and forest product sectors.

  Ontario Centre for Farm Equipment and Food Processing. The Centre will receive $10 million over five years to develop and promote the adoption of advanced technology in the farm equipment and food processing sectors.

  Ontario Centre for Advanced Manufacturing. A CAD/CAM Centre in Cambridge and a Robotics Centre in Peterborough together will receive $40 million over five years to accelerate the use of advanced technologies by Ontario manufacturers and to promote the growth of supporting industries.

  Ontario Centre for Microelectronics. BILD will contribute $20 million over five years to the Centre, which will focus on the diffusion of microelectronics technology in products and production processes throughout Ontario industry.
- **Allelix Inc.** The Ontario Government, through BILD, has agreed to provide $30 million to establish a biotechnology company in co-operation with Canada Development Corporation and John Labatt Ltd. Along with the IDEA Corporation, Allelix will encourage individuals, entrepreneurs and firms to participate in the emerging biotechnology industry.

- **Telidon: Teleguide.** BILD has agreed to provide $5 million towards the $15 million Teleguide project, which involves 250 Telidon terminals being installed throughout Metropolitan Toronto where tourists and residents can access entertainment and other information. This is a major demonstration of Telidon's capabilities in a mass market and may be instrumental in developing a market for Ontario's Telidon industry.
- **Institute for Hydrogen Systems.** The Ministry of Energy, with BILD support, is committing $8.6 million over five years, to establish the Institute in a joint venture with the University of Toronto. The Institute includes government, university and private sector interests engaged in hydrogen research, development, demonstration and commercialization. With its well-established, low-cost nuclear electric capability, Ontario is in an excellent position to capitalize on this emerging technology.

Ontario Research Foundation

In 1982, the Ontario Research Foundation served 2,100 industrial clients. Half were small businesses. The services ranged from routine testing to highly innovative research and development of new products and processes. Provincial support consists of an annual performance grant. In 1982, the Province provided a performance grant of $4.3 million, about 25 per cent of operating costs, and an additional $500,000 towards the purchase of lab equipment.

Assistance for Small Business Innovation

The following Ontario Government programs assist small businesses during various stages of the innovative process:

- The Product Development Management Program (PDMP) is co-sponsored by the Ontario Government and Design Canada. Grants of up to $20,000 per project are available for outside consultants to assist a firm with product design.
- The Technical Assessment and Planning Program (TAP) assists eligible firms in obtaining the consulting services of research scientists, engineers, and technologists. Financial assistance is provided up to a maximum of $3,600 per project.
- The Program to Encourage Product and Process Innovation (PEPPI) helps small business entrepreneurs build and test a prototype of an innovation in order to assess its commercial feasibility. Grants of up to $10,000 are available for each eligible project.
- The Promotional Aids Program (PAP) provides funds to cover half the cost of an approved marketing project up to a maximum of $7,500. The program emphasizes new product assistance.

Highly-Qualified Manpower

The most important way in which Ontario supports the universities' involvement in research and training of research manpower is through support of graduate-level education. The universities received $186 million in operating grants based on graduate enrolments in 1981-82 and $206 million in 1982-83.

The Province also provides considerable direct financial support for university research. BILD has provided $10 million in grants for university research in 1981-82 and $7.5 million in 1982-83. Of the $17.5 million total, $13.2 million was allocated to purchase research equipment and $4.3 million to match research grants from the

private sector. Various Ontario ministries also sponsor research related to their responsibilities. In 1981-82, Ontario provided a total of $35.8 million to universities for sponsored research.

VII Structural Policies Supportive of R&D

Although Canada continues to invest a smaller share of its resources in R&D than other advanced industrialized countries, this relatively low R&D performance is attributable to a number of specific structural characteristics of the Canadian economy:

- The manufacturing sector, which accounts for the bulk of R&D performed by business, is comparatively small in Canada and this restricts the potential for industrial R&D.
- Canada does not maintain as large a defence-related R&D program as do most other major OECD countries.
- The higher unit costs of innovation in Canada's limited domestic market reduces the incentive for firms to undertake R&D.
- In industries with scope for technology-based innovation, Canada has few firms equal in size to their international competitors which similarly reduces the attractiveness of R&D-intensive corporate strategies.
- The high degree of foreign ownership in Canada depresses R&D performance relative to that in other countries.

Several of the structural factors inhibiting industrial R&D performance are simply Canadian realities which public policy cannot or should not change. For example, Canada should not forgo its tremendous opportunities for natural resource development, simply because these activities are typically less R&D-intensive than some manufacturing industries. Similarly, the level of Canada's expenditures on defence is an issue of foreign policy.

Other structural impediments to R&D performance, however, can be addressed through public policies. For example, Canada's problems of small market and firm size and non-resident ownership may be overcome through appropriate policies on international trade, competition and foreign investment.

Trade Policy

Trade liberalization would significantly benefit Canada's research-intensive industries. Both the performance of R&D and its successful commercialization appear to be strongly correlated with market size. In a world where trade is restricted, economies of scale in R&D, ready access to potential demand and the availability of a large pool of highly-skilled labour all contribute to the development of new technology in large countries. Without the benefit of a large home market, Canadian producers are more vulnerable to foreign protectionism than their competitors and thus have a greater stake in an open multilateral trading system.

While the General Agreement on Tariffs and Trade (GATT) has had considerable success in reducing general tariff rates on most manufactured products, little progress has been achieved in dealing with the growing incidence of discriminatory public procurement practices and other forms of non-tariff protection. Many key public sector goods continue to be outside the scope of GATT procurement regulations as evidenced by the recent Tokyo Round exemptions for telecommunication and mass transit equipment. Purchasing preferences given to domestic producers by governments and publicly-regulated industries restrict imports of these products in the major-

ity of OECD markets. This has been particularly harmful to Ontario's highly-developed telecommunications and mass transit sectors. The pursuit of an open multilateral trading system must continue to remain an important priority for the development of Canadian high-technology industries.

Competition Policy

Competition policy should not be a barrier to R&D. Inflexible merger regulations can stifle both the incentive and capacity for industrial innovation by preventing the efficient consolidation of smaller firms. Larger firms are able to draw on the managerial strength and financial depth necessary to sustain a commercially successful R&D effort. The importance of large firms for industrial R&D is a key element underlying Ontario's concern over recent federal proposals to overhaul Canadian competition law.

The federal proposal to regulate merger activity on the basis of an arbitrary market share criterion is both unnecessary from the standpoint of competition and damaging with respect to our industrial efficiency. Conventional measures of industrial concentration do not necessarily reflect the market power of larger firms when international factors are considered. The potential for monopolistic pricing normally associated with concentration in a closed economy is substantially mitigated by the competitive threat posed by potential increases in the level of import penetration in the domestic market. Moreover, there is some pressure on export-oriented firms to maintain lower domestic prices.

Foreign Investment Policy

Past policies, principally high tariff protection, attracted foreign investment in the form of branch plants. The transition to an environment in which foreign direct investment is based on product specialization and global market mandates is significantly enriching the R&D opportunities available to foreign-owned subsidiaries in Canada. Ontario has actively encouraged this process and an increasing number of the Canadian operations of multinationals in the province are rationalizing to take advantage of global markets. International trade liberalization has provided a powerful lever for rationalization. However, there remains scope for company-specific bargaining to ensure that multinational firms explore all possible approaches to the efficient location of a greater share of their R&D work in the province. The Foreign Investment Review Agency can play a positive role in achieving this objective by emphasizing R&D performance in its evaluation of the significant benefits of an investment in Canada.

Conclusion

Canada's R&D record indicates several important positive trends since the mid-1970s. The most significant is the increase in R&D performance as a per cent of GNP from 0.96 per cent in 1976 to an estimated record of 1.39 per cent in 1983. A second trend is the increasing role of business in the performance and funding of R&D. In 1976, business performed 42 per cent and funded 34 per cent of total R&D. Statistics Canada now estimates that business will perform 56 per cent and fund 46 per cent of R&D in 1983. Despite these impressive gains, Canada continues to invest a smaller share of its resources in R&D than other advanced industrialized economies.

The tax assistance provided for industrial R&D in Canada is the most generous in the industrialized world. The measures introduced and the proposals advanced for discussion in the April 19, 1983 federal budget would reinforce this relative advantage.

In view of this, additional provincial tax incentives for R&D do not appear to be warranted. However, there may be a need to restructure provincial incentives to increase their effectiveness. Any restructuring of incentives should be approached cautiously, taking into account the potentially damaging effects that too frequent changes can have on the R&D investment climate.

In the design of public policy to promote R&D, consideration should be given to the structural factors that account for Canada's relatively low R&D performance in international comparisons. Some of these factors, for example Canada's comparative advantage in resources, are Canadian realities that public policy cannot or should not attempt to change. Other structural impediments to R&D performance, however, can be mitigated by appropriate economic policies. International trade policies which continue the trend towards trade liberalization are important in order to overcome the disadvantages of small market and firm size. Competition policy, in an open and export-oriented economy, should avoid creating barriers to mergers intended to facilitate firm-level economies of scale in R&D or other aspects of innovation. Public policy towards foreign ownership should encourage world product mandates for Canadian subsidiaries which permit them to research, develop, produce and market products on a global basis. Since these policies need not involve any additional expenditure of public funds, they provide a particularly cost-effective means of supporting R&D.

An increasing priority for policy is to create an environment more conducive to R&D performance. This can be done by expanding opportunities for the commercialization of innovations and by accelerating the pace at which innovations are diffused throughout the economy. The Ontario Government has recognized this need. In addition to direct support for R&D activity, Ontario's Board of Industrial Leadership and Development has taken steps to promote commercialization and diffusion of technology through its funding of the IDEA Corporation and the technology centres program.

In conclusion, it is apparent that a wide range of public policies affects the performance of R&D by industry. While discussion in the past has tended to focus on funding private R&D through tax expenditures, a number of other expenditure and structural policies need to be taken into account. In part, this reflects the fact that R&D performance is not an end in itself. For the gains of R&D to be realized, an innovation first must be successfully commercialized. The policies most likely to successfully promote the commercialization and diffusion of innovations are those that integrate R&D into the broader context of economic development.

Appendix: International Comparison of Tax Treatment of R&D

This Appendix briefly describes the corporation income tax treatment of R&D expenditures in five major industrialized countries. On balance, the special provisions for R&D of these countries are less generous than are those available to firms in Canada.

United States

Current expenditures:

- fully deductible in the first year; and
- unused deductions may be carried back 3 years and forward 15 years.

Capital expenditures:

- may be depreciated over a period as short as 3 years and as long as 15 years, depending upon the nature of the expenditure (for example, equipment over 3 years and structures over 15 years);
- some equipment (excluding buildings and structures) is eligible for a 6 to 10 per cent tax credit, which is not taxable; and
- the carry-over provision for unused deductions and credits is the same as that provided for current expenditures.

Incremental expenditures:

- as of 1981, a non-taxable tax credit of 25 per cent of incremental expenditure is available, until 1986;
- the qualifying expenditures are current expenses including in-house and contract research expenses, such as salaries, wages and rental charges for equipment, and 65 per cent of payments to research firms or universities;
- incremental expenditures are determined as the excess of expenditure over the average of the three preceding years; and
- unused credits may be carried back 3 years and forward 15 years.

United Kingdom

Current expenditures:

- fully deductible in the first year; and
- unused deductions may be carried back 3 years and forward indefinitely.

Capital expenditures:

- the same as that for current expenditures.

Japan

Current expenditures:

- fully deductible in the first year; and
- unused deductions may be carried back 1 year and forward 5 years.

Capital expenditures:

- depreciable over the useful life; and
- additional deduction in the year of acquisition is available for certain expenditures, but total deduction cannot exceed expense.

Incremental expenditures:

- a tax credit equal to 20 per cent of the excess of current expenditures plus depreciation and overhead expenses over the largest amount of such expenditures in any prior year since 1966;
- the credit is not taxable but is subject to a maximum of 10 per cent of corporate income tax payable; and
- unused deductions and credits may be carried back 1 year and forward 5 years.

Special incentives:

- a deduction of up to 40 per cent of taxable income is available for firms which derive all or part of their income from "overseas transactions in technical services" (for example, copyrights and patents).

West Germany

Current expenditures:

- fully deductible in the first year, with a 5-year carry forward on unused deductions.

Capital expenditures:

- expenses of up to DM 800 (about $400 Canadian) are allowed an immediate write off, with the excess depreciated over the economic life of the asset;
- an exception is made for expenditures undertaken in Berlin and in areas bordering East Germany where an additional deduction (on top of the straightline depreciation) of between 40 per cent and 75 per cent of the expense is provided;
- unused deductions may be carried back one year up to a maximum of DM 5 million (about $2.5 million Canadian) and carried forward for up to 5 years; and
- in the year of acquisition of any depreciable asset used to perform R&D, a non-taxable tax credit equal to 20 per cent of the first DM 500,000 (about $250,000 Canadian) and 7.5 per cent on the balance. The credit is refundable.

France

Current expenditures:

- fully deductible in the first year with unused deductions carried forward for up to 5 years.

Capital expenditures:

- depreciable over the useful life;
- effective January 1, 1983, a 25 per cent investment tax credit based on the increase over previous year's expenditure with a maximum credit of FF 3 million annually (about $500,000 Canadian), replacing the previous fast write-off provisions; and
- the carry-over provision is the same as that allowed for current expenditures.

Special incentives:

- companies developing scientific or technical research are entitled to a cash grant of 15 to 20 per cent of expenditures up to a maximum of FF 25,000 (about $4,200 Canadian) per job created, provided at least 10 permanent jobs are created.